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Ministry of Environment and Energy

FOR YOUR information

JULY 1996

Water pollution monitoring costs in Ontario Comparison of estimated and actual costs

Summary of report

PURPOSE OF REPORT

The Municipal-Industrial Strategy for Abatement (MISA) program is intended to achieve the "virtual elimination of toxic contaminants in municipal and industrial discharges into Ontario waterways". As a first step in this program, regulations required intensive monitoring of industrial wastewater discharges over 12 months. A total of 237 plants in 9 industrial sectors implemented these monitoring programs between December 1988 and July 1991.

Prior to the implementation of the monitoring programs, industrial representatives and Ministry staff produced estimates of the capital and operating costs of monitoring activities at each plant. Before completing year-long monitoring programs, the plants were sent questionnaires asking for data on the actual expenditures incurred for monitoring.

In this report, monitoring activities required by the regulations are described and key results of monitoring efforts are summarized. This is the first time that actual costs of a regulatory program have been collected in Ontario for comparison with pre-program estimates.

KEY RESULTS OF EFFLUENT MONITORING ACTIVITIES

In addition to the concentration of various chemicals, tests were carried out to determine acidity and acute toxicity. Monitoring revealed different numbers of contaminants or pollution parameters in effluents from each sector.

The contaminants or pollution parameters monitored for and detected varied for each industrial sector. The most parameters, 161, were tested for in Metal Casting plants. The largest number of parameters detected in one industrial sector was 116 at the Organic Chemical plants. Eleven of the 26 Organic Chemical plants monitored had effluents that were acutely lethal to fish and other aquatic organisms. Over half of the samples tested from the Pulp and Paper mills were toxic to aquatic life.

Using monitoring data, abatement cost estimates, and other information on financial impacts, maximum allowable limits were developed for specific pollution parameters in each sector ranging from 59 contaminants in the Organic Chemical Sector plants to 1 parameter for Industrial Minerals plants.

ESTIMATED COSTS OF MONITORING ACTIVITIES

Estimated monitoring costs totalled $73.7 million for 237 plants, or an average of $311,100 per plant. Operating expenses were estimated to represent 65% of the total expenses. Disaggregated estimates were developed for each monitoring activity: sampling ($25.6 million), flow measurement ($12.9 million), characterization ($11.8 million), routine analysis ($16.2 million), toxicity testing ($1.6 million), reporting ($5.1 million) and other ($512,300).

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The highest total monitoring costs were in the Iron and Steel sector, with 7 plants, averaging $1.2 million per plant. In contrast, the 51 Industrial Minerals plants were expected to incur the least total cost per plant of $38,900. It was estimated that the 7 Iron and Steel plants would incur the highest capital and operating costs per plant; $732,000 and $464,000 per plant respectively.

REPORTED COSTS OF MONITORING ACTIVITIES

Of the 220 plants or mines surveyed, 117 or 53% returned completed questionnaires as shown in Table 1.

Table 1: Response rate of MISA monitoring cost survey

Sector	Number of monitoring plants		
	Received a questionnaire	Fully completed a questionnaire and returned it to MOEE	% of response
Petroleum refining	7	7	100%
Organic chemicals	26	24	92%
Pulp and paper	27	17	63%
Iron and steel	7	1	14%
Metal mining	47	14	30%
Industrial minerals	47	5	10%
Electric power	22	22	100%
Inorganic chemicals	29	25	86%
Metal casting	8	2	25%
Total	220	117	53%

Source: MOEE, Actual Cost of Monitoring Survey, 1991.

As shown in Table 2, these 117 plants reported spending a total of $52.9 million, or an average of $452,000 per plant on monitoring activities. This cost per plant is 45% higher than the $311,000 per plant that was estimated prior to the implementation of the monitoring. Total reported capital and operating costs were split 50-50. Operating expenditures include $10.2 million to hire external consultants. Total capital and operating cost per plant were $224,000 and $228,000 respectively.

Table 2: Total reported capital and operating costs of monitoring by sector

Sector	($'000)			
	# of plants	Capital (1)	Operating (2)	Total
Metal casting	2	5.2	38.5	43.7
Industrial minerals	5	105.2	279.5	384.7
Iron and steel	1	699.3	1,007.2	1,706.5
Metal mining	14	357.8	1,423.9	1,781.7
Petroleum refining	7	1,835.8	2,236.5	4,072.3
Inorganic chemicals	25	1,795.6	2,890.7	4,686.3
Pulp and paper	17	2,470.4	2,691.8	5,162.2
Organic chemicals	24	5,382.8	7,253.6	12,636.4
Electric power	22	13,554.9	8,916.0	22,470.9
Total	117	26,207.0	26,737.7	52,944.7

(1) Actual capital costs include purchased vehicles.
(2) Actual operating costs include consultant and vehicle leased costs.

Source: MOEE, Actual Cost of Monitoring Survey, 1991

The 22 Electric Power Generating plants reported the largest total monitoring expenditures of $22.5 million. The lowest total sector expenditure amounted to $43,700 by 2 Metal Casting plants.

As shown in Table 3, the single reporting steel plant had the largest total monitoring expenditure per plant of $1.7 million.

Metal Casting foundries reported spending the smallest cost per plant; $21,900 per plant.

Total expenditures reported by monitoring function included $14.2 million (26.8%) for sampling, $11.9 million (22.6%) for analytical testing, $10.4 million (19.7%) for flow measurement, $5 million (9.5%) for reporting, and $1.1 million (2.2%) for training, seminars and transportation .

Table 3: Total reported monitoring cost per plant

Sector	# of plants	($'000) Total	Total cost per plant
Metal casting	2	43.7	21.9
Industrial minerals	5	384.7	76.9
Metal mining	14	1,781.7	127.3
Inorganic chemicals	25	4,686.3	187.5
Pulp and paper	17	5,162.2	303.7
Organic chemicals	24	12,636.4	526.5
Petroleum refining	7	4,072.3	581.8
Electric power	22	22,470.9	1,021.4
Iron and steel	1	1,706.5	1,706.5
Total	117	52,944.7	452.5

Note:

(1) Actual capital costs include purchased vehicles.

(2) Actual operating costs include consultant and vehicle leased costs

Source: MOEE, Actual Cost of Monitoring Survey, 1991

External consultants performed chemical analyses ($6.4 million) and toxicity testing ($1.0 million). The 117 reporting plants established 210 consulting contracts with 55 consulting firms, for an average cost of $42,600 per contract.

ESTIMATED AND REPORTED COSTS OF MISA MONITORING ACTIVITIES

Pre-regulation cost estimates and reported costs are available for 99 out of the 117 plants that returned completed questionnaires. Actual and estimated costs for these plants were compared to evaluate the degree of over/under estimation and to determine reasons for such discrepancies. Total estimated monitoring costs for all plants were $7.2 million (14%) less than total reported costs. However, total costs were over-estimated by as much as 248% in the Metal Mining Sector, and under-estimated by as much as 43% in the Electric Power Sector. Under-estimation of the Electric Power sector was due to the fact that additional monitoring requirements, not included in the cost estimates, were imposed in the monitoring regulations.

The range of error varied from -40%/+19% in the Petroleum Refining Sector to +65%/+1,053% in the Metal Mining Sector.

Statistical analyses demonstrated that estimated monitoring costs in the Petroleum, Pulp and Paper and Organic and Inorganic Chemical sectors were good estimators of the actual costs.

Table 4: Reporting versus estimated total monitoring costs by sector

Sector	Number of plants (for which both estimated and reported costs are available)	Estimated capital costs ($'000)	Reported capital costs* ($'000)	Capital costs % difference (EST — REP/REP)	Estimated operating costs ($'000)	Reported operating costs** ($'000)	Operating costs % difference (EST — REP/REP)	Estimated total costs ($'000)	Reported total costs ($'000)	Total costs % difference (EST — REP/REP)
Petroleum refining	7	1,575.0	1,835.8	-14%	2,081.0	2,236.5	-7%	3,656.0	4,072.3	-10%
Organic chemicals	14	2,024.0	4,900.9	-59%	5,335.3	6,325.9	-16%	7,359.3	11,226.8	-34%
Pulp and paper	17	2,189.2	2,470.4	-11%	3,545.4	2,691.8	32%	5,734.6	5,162.2	11%
Iron and steel	1	1,981.9	699.3	183%	851.0	1,007.2	-16%	2,832.9	1,706.5	66%
Metal mining	14	2,134.7	357.8	497%	4,060.4	1,423.9	185%	6,195.1	1,781.7	248%
Industrial minerals	3	14.5	15.5	-6%	133.1	115.9	15%	147.6	131.4	12%
Electric power generation	22	5,274.7	13,554.9	-61%	7,558.2	8,916.0	-15%	12,832.9	22,470.9	-43%
Inorganic chemicals	19	1,189.2	1,704.7	-30	3,636.5	2,614.3	39%	4,825.7	4,319.0	12%
Metal casting	2	3.3	5.2	-37%	30.2	38.5	-22%	33.5	43.7	-23%
Total	99	16,386.5	25,544.5	-36%	27,231.1	25,370.0	7%	43,617.6	50,914.5	-14%

Note:

* *Actual capital costs include purchased vehicle costs.*

** *Actual operating costs include consultant and vehicle leased costs.*

Source:

Estimated costs – various MISA estimated monitoring cost reports prepared by MOEE.

Reported costs – MOEE, actual cost of monitoring survey, 1991.

EMPLOYMENT ASSOCIATED WITH MONITORING REQUIREMENTS

The 117 survey respondents reported that a total of 106 persons were hired to perform in-house monitoring activities. Of these 106, 62 were hired on a permanent basis while 44 were hired temporarily for one year as shown in Table 5. Organic Chemical plants hired the largest number of additional employees, consisting of 23 permanent and 16 temporary persons. Ontario Hydro employed an added 18 people on a permanent basis.

Table 5: Reported number of additional employees hired in-house to perform MISA monitoring activities

Sector	Permanent		Temporary		Total
	Full-time	Part-time	Full-time	Part-time	
Petroleum refining	4	0	2	1	7
Organic chemicals	21	2	12	4	39
Pulp and paper	8	1	3	1	13
Iron and steel	1	0	2	0	3
Metal mining	0	1	5	0	6
Industrial minerals	0	0	0	0	0
Electric power	15	3	4	7	29
Inorganic chemicals	6	0	1	2	9
Metal casting	0	0	0	0	0
Total (117 plants)	55	7	29	15	106

Source: MOEE, Actual Cost of Monitoring Survey, 1991.

The 117 survey respondents reported a total of 343,416 person hours to perform in-house monitoring activities. As shown in Table 6, reported operating costs per total person in-house hours were much higher and ranged between $63.40 per hour in the Petroleum sector to $161.80 per hour in the Metal Casting Sector.

Table 6: Monitoring person hours as a % of reported monitoring costs

Sector	Reported operating costs ($'000)	In-house person hours	Operating costs per total person hours ($/hr)
Petroleum refining	2,236.5	35,282	63.4
Organic chemicals	7,253.6	89,355	81.2
Pulp and paper	2,691.8	36,308	74.1
Iron and steel	1,007.2	14,978	67.2
Metal mining	1,423.9	16,860	84.4
Industrial minerals	279.5	2,917	95.8
Electric power	8,916.0	108,693	82.0
Inorganic chemicals	2,890.7	38,785	74.5
Metal casting	38.5	238	161.8
Total (117 plants)	26,737.7	343,416	n/a

Source: MOEE, Actual Cost of Monitoring Survey, 1991.

Required in-house person hours to perform various monitoring activities differed greatly among sectors; from 119 person-hours per plant in the Metal Casting sector to as high as 14,978 person- hours for the one reported Iron and Steel plant. Total person in-house hours by monitoring function were 127,135 hours (37%) for analytical testing, 114,469 hours (33%) for sampling, 81,098 hours (24%) for reporting and 20,714 hours (6%) for flow measurement.

CONCLUSIONS

Estimated compliance costs for individual sectors and individual plants provide the basis for assessing the cost-effectiveness and the financial and economic implications of proposed regulations or policies prior to their implementation. However, these estimates are seldom verified by comparing them against actual costs incurred. The 117 plants which responded to the survey questionnaire reported actual monitoring expenses averaging $452,000 per plant. If this average monitoring cost applied across the 273 plants covered by the monitoring regulations, total plant monitoring costs to comply with the regulations would have been $123.5 million.

Of the 117 respondents to the survey, only 99 plants also had cost **estimates** generated. Estimated total monitoring costs for these 99 plants were only 14% lower than total actual costs obtained from the survey. The major discrepancy was with the capital costs which were 36% lower than the reported costs.

The largest discrepancies between estimated and reported **capital** costs were found in Electric Power, Organic Chemicals, Metal Mining and Iron and Steel plants. According to industry sources, capital costs are often underestimated because installation of instrumentation and construction of facilities is frequently more complex and costly than anticipated. Moreover, actual capital monitoring costs for Electric Power plants were higher than estimates because additional monitoring requirements were imposed by the regulation which were not included in the estimates.

Estimated **operating** costs were 7% higher than survey costs. The largest difference between estimated and actual operating costs was in the Metal Mining sector, where estimated operating costs were 185% higher than the actual reported costs. About 74% of this difference was due to an overestimation of costs to hire external consultants.

The range of error (level of accuracy) of estimates was calculated for each industrial plant and sector. For example, monitoring cost estimates for Petroleum refineries were under-estimated by as much as 40% or over-estimated by as much as 19%.

Consequently, the estimated monitoring expenditures derived for the Petroleum, Pulp and Paper, Organic and Inorganic chemical sectors are good predictors of the values of the actual costs.

The Economic Services Branch has produced and analyzed estimates of pollution abatement and prevention costs for many types of environmental issues. Compliance cost estimates provide the basis for assessing cost-effectiveness and the financial and economic implications of proposed regulations and policies. However, these estimated are seldom verified by comparing them against actual costs incurred. Determination of the accuracy of cost estimates will provide a stronger basis for developing future environmental policies.

FOR MORE INFORMATION

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